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(54) **METHOD FOR SPUTTERING TINI
SHAPE-MEMORY ALLOYS**

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216/41, 96, 100

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,668,131 A * 6/1972 Banush et al. 216/103
3,991,898 A * 11/1976 Hanson et al. 220/592.2
5,061,914 A 10/1991 Busch et al.
5,474,563 A * 12/1995 Myler et al. 606/108
5,772,864 A * 6/1998 Moller et al. 205/73
6,096,175 A * 8/2000 Roth 204/192.15
6,107,004 A * 8/2000 Donadio, III 430/320
6,224,626 B1 * 5/2001 Steinke 623/1.16
6,379,383 B1 * 4/2002 Palmaz et al. 623/1.49
2001/0032013 A1 * 10/2001 Marton 623/1.15

FOREIGN PATENT DOCUMENTS

WO WO 99/62432 12/1999

OTHER PUBLICATIONS

J Busch et al. "Shape-memory properties in Ni-Ti sputter-deposited film", Dec. 15, 1990, Journal of Applied Physics vol. 68, Issue 12 (abstract only).*

S. Miyazaki et al. "Martensitic Transformations in sputter-deposited Ti-Ni-Cu shape memory alloy thin films", 1996, Thin Solid Films, 281-282, Elsevier, pp. 364-367.*

Dario, P. and Montesi, M.C., "Shape Memory Alloy Microactuators for Minimally Invasive Surgery", *Proceedings of SMST-94 Conference*, pp. 427-433, Pacific Grove CA, (1994).

Johnson, A.D., "Vacuum-Deposited TiNi Shape Memory Film: Characterization and Applications in Microdevices", *J. Micromech. Microeng.* 1:34-41, (1991).

Kruelevitch, P. et al., "Thin Film Shape Memory Alloy Microactuators", *J. Micromech. Microeng.* 5(4):270-282, (1996).

Schetky, L.M., "Shape-Memory Alloys", *Scientific American* 74-82, (1979).

* cited by examiner

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(57) **ABSTRACT**

A thin film device, such as an intravascular stent, is disclosed. The device is formed of a seamless expanse of thin-film (i) formed of a sputtered nitinol shape memory alloy, defining, in an austenitic state, an open, interior volume, having a thickness between 0.5-50 microns, having an austenite finish temperature A_f below 37° C.; and demonstrating a stress/strain recovery greater than 3% at 37° C. The expanse can be deformed into a substantially compacted configuration in a martensitic state, and assumes, in its austenitic state, a shape defining such open, interior volume. Also disclosed is a sputtering method for forming the device.

11 Claims, 4 Drawing Sheets